U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-281 857

Hills Creek Reservoir
Lane County, Oregon

National Eutrophication Survey, Corvallis, Oreg

Prepared for

Corvallis Environmental Research Lab, Oreg

Jan 78

PB 281 857

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

699-440

Report

on

Hills Creek Reservoir

Lane County

Oregon

EPA Region X

Working Paper No. 830

With the cooperation of the

Oregon Department of Environmental Quality

and the

Oregon National Guard

January, 1978

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO. PB281857
4. TITLE AND SUBTITLE Report on Hills Creek Reservoir, Lane County Oregon		5. REPORT DATE Prepared January 1978
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)		8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 830
9. PERFORMING ORGANIZATION NAME AND ADDRESS Pacific Northwest Environmental Research Laboratory U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330		10. PROGRAM ELEMENT NO. 1BA029
		11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460		13. TYPE OF REPORT AND PERIOD COVERED Final - 1975
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading	National Eutrophication Survey Lake Survey	05B 05C

18. DISTRIBUTION STATEMENT Release Unlimited	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 40
	20. SECURITY CLASS *(This page)*	22. PRICE A03-A01

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

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Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Oregon Department of Environmental Quality for the professional involvement and to the Oregon National Guard for conducting the tributary sampling phase of the the Survey.

William H. Young, Department Director, and Harold L. Sawyer, Administrator, and the staff of the Water Quality Control Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

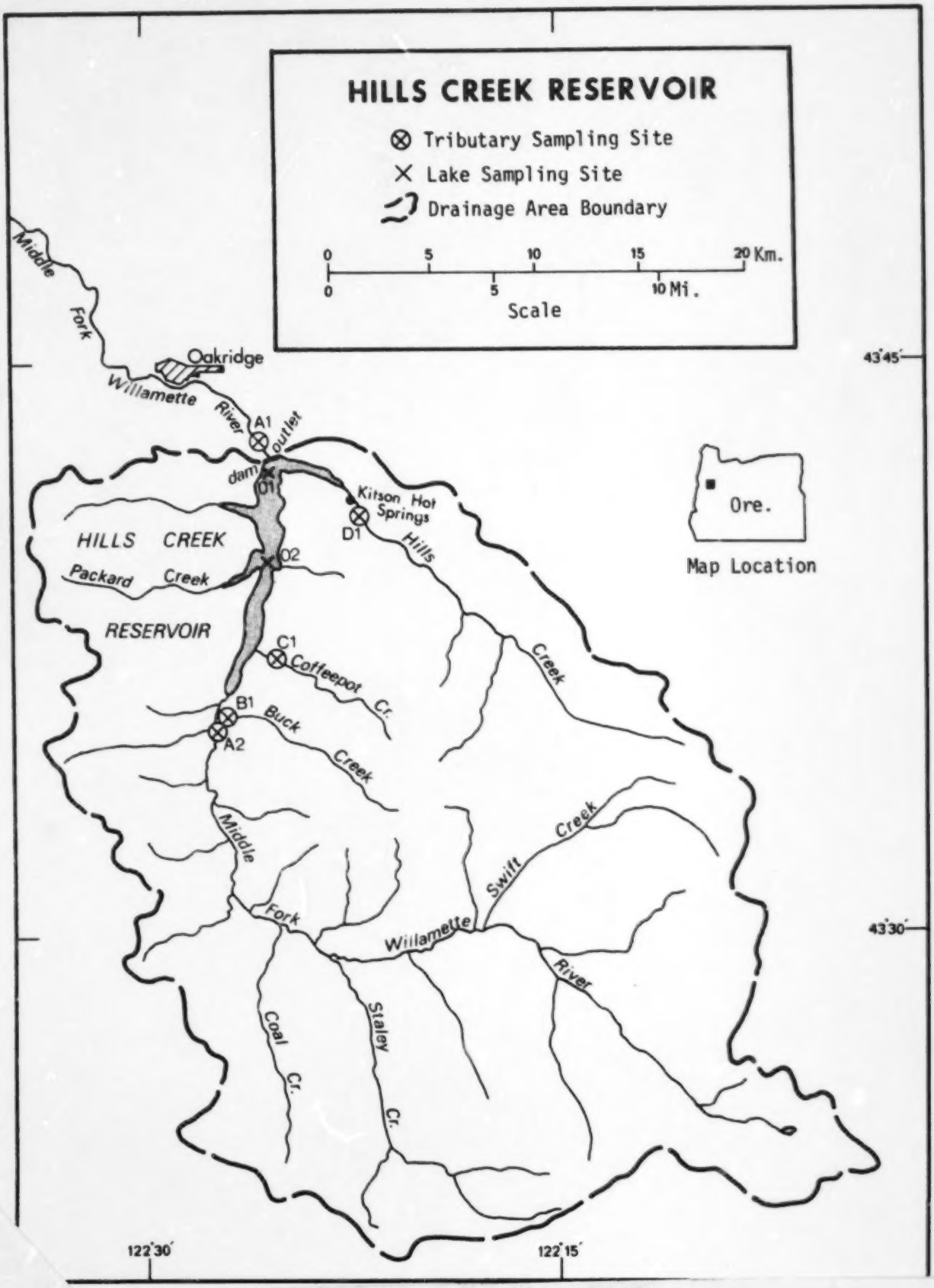
Brigadier General Richard A. Miller, the Adjutant General of Oregon, and Project Officer Lt. Colonel John Mewha, who directed the volunteer efforts of the Oregon National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES and RESERVOIRS

STATE OF OREGON

NAME	COUNTY
Brownlee	Baker, OR; Washington, ID
Diamond	Douglas
Hells Canyon	Baker, Wallowa, OR; Adams, Idaho, ID
Hills Creek	Lane
Owyhee	Malhuer
Oxbow	Baker, OR; Adams, ID
Suttle	Jefferson
Waldo	Lane


HILLS CREEK RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
0 5 10 15 20 Km.
0 5 10 Mi.
Scale
Middle Fork Willamette River
Oakridge
A1
outlet
dam
O1
Kitson Hot Springs
D1
Hills Creek
HILLS CREEK
Packard Creek
O2
RESERVOIR
C1
Coffeepot Cr.
B1
A2
Buck Creek
Middle Fork
Swift Creek
Willamette River
Coal Cr.
Staley Cr.
Ore.
Map Location
43°45′
43°30′
122°30′
122°15′

HILLS CREEK RESERVOIR

STORET NO. 4104

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate Hills Creek Reservoir is eutrophic. It ranked fourth in overall trophic quality when the eight Oregon lakes and reservoirs sampled in 1975 were compared using a combination of six parameters*. Three of the water bodies had less median total phosphorus, dissolved orthophosphorus, and inorganic nitrogen; one had less mean chlorophyll a, and all but one of the other water bodies had greater mean Secchi disc transparency.

Survey limnologists did not observe surface concentrations of algae, but summer blooms of blue-green algae (Anabaena sp.) have been reported (Larson, 1974).

B. Rate-Limiting Nutrient:

Because of significant changes in nutrients in the sample between the time of collection and the beginning of the algal assay, the results are not considered representative of conditions in the reservoir at the time the sample was collected (10/30/75).

The reservoir data indicate nitrogen limitation all three sampling times. However, because of turbidity (Klingeman et al., 1971), primary productivity probably is light-limited.

C. Nutrient Controllability:

1. Point sources--No known municipal or industrial point sources impacted the reservoir during the sampling year. Septic

* See Appendix A.

tanks serving lakeshore dwellings were estimated to have contributed less than 0.1% of the total phosphorus load, but a shoreline survey is needed to determine the significance of those sources.

The present phosphorus loading of 3.66 $g/m^2/yr$ is more than twice that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 11). Though the high turbidity of the reservoir may be suppressing primary production, every effort should be made to minimize phosphorus inputs to slow the aging of the reservoir.

2. Non-point sources--Non-point sources, including direct precipitation, added over 99.9% of the total phosphorus load during the sampling year. The Middle Fork Willamette River added 70.9% of the total load; Hills Creek, 10.9%; and the ungaged tributaries contributed an estimated 17.7%.

The phosphorus export rate of Middle Fork Willamette River and Hills Creek were 43 and 32 $kg/km^2/yr$ (see page 10). These export rates are considerably higher than those of unimpacted forested watersheds in the eastern United States (Omernik, 1976). The higher rates may be due to unstable soil materials in the watersheds (Klingeman et al., op. cit.).

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 11.07 kilometers^2.

2. Mean depth: 39.2 meters.

3. Maximum depth: 90.5 meters.

4. Volume: 433.571 x 10^6 m^3.

5. Mean hydraulic retention time: 152 days.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Middle Fork Willamette River	668.2	22.37
Hills Creek	136.5	4.31
Minor tributaries & immediate drainage -	191.7	6.36
Totals	996.4	33.04**

2. Outlet -

Middle Fork Willamette River	1,007.5***	33.04

C. Precipitation****:

1. Year of sampling: 123.4 centimeters.

2. Mean annual: 117.0 centimeters.

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† Table of metric conversions--Appendix B.
†† Anonymous, 1972; Martin and Hanson, 1966.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Sum of inflows adjusted to equal outflow.
*** Includes area of reservoir.
**** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Hills Creek Reservoir was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at two stations on the reservoir (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 67.1 meters at station 1 and 54.9 meters at station 2.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR HILLS CREEK RESERVOIR
STORET CODE 4104

PARAMETER	1ST SAMPLING (3/28/75) 2 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (7/16/75) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (10/30/75) 2 SITES RANGE	MEAN	MEDIAN
TEMP (C)	4.5 - 6.2	5.6	5.8	3.0 - 19.5	12.0	13.1	5.7 - 14.0	10.9	12.3
DISS OXY (MG/L)	10.4 - 11.6	11.3	11.5	8.2 - 15.4	10.0	9.3	7.6 - 9.8	8.8	9.0
CNDCTVY (MCROMO)	32. - 48.	40.	40.	15. - 41.	28.	28.	23. - 50.	41.	40.
PH (STAND UNITS)	7.2 - 7.8	7.5	7.4	6.9 - 9.3	8.2	8.3	6.9 - 7.9	7.2	7.2
TOT ALK (MG/L)	20. - 23.	22.	22.	19. - 30.	25.	25.	28. - 33.	31.	31.
TOT P (MG/L)	0.038 - 0.059	0.044	0.043	0.017 - 0.045	0.029	0.026	0.022 - 0.061	0.034	0.031
ORTHO P (MG/L)	0.030 - 0.041	0.035	0.034	0.012 - 0.038	0.025	0.026	0.007 - 0.028	0.017	0.014
NO2+NO3 (MG/L)	0.020 - 0.040	0.023	0.020	0.020 - 0.080	0.034	0.030	0.020 - 0.080	0.038	0.030
AMMONIA (MG/L)	0.020 - 0.040	0.024	0.020	0.030 - 0.090	0.049	0.045	0.020 - 0.020	0.020	0.020
KJEL N (MG/L)	0.200 - 0.400	0.217	0.200	0.200 - 1.200	0.321	0.250	0.200 - 0.200	0.200	0.200
INORG N (MG/L)	0.040 - 0.070	0.047	0.040	0.050 - 0.170	0.082	0.075	0.040 - 0.100	0.058	0.050
TOTAL N (MG/L)	0.220 - 0.430	0.240	0.220	0.220 - 1.280	0.355	0.285	0.220 - 0.280	0.238	0.230
CHLRPYL A (UG/L)	0.6 - 1.0	0.8	0.8	3.8 - 4.2	4.0	4.0	1.7 - 2.7	2.2	2.2
SECCHI (METERS)	1.4 - 1.5	1.4	1.4	1.8 - 2.0	1.9	1.9	1.5 - 1.5	1.5	1.5

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/28/75	1. *Chroomonas* (?) *sp.*	219
	2. *Cryptomonas sp.*	17
	Total	236
07/16/75	1. *Fragilaria sp.*	1,569
	2. *Cryptomonas sp.*	297
	3. *Asterionella sp.*	212
	4. *Chroomonas* (?) *sp.*	42
	Total	2,120
10/30/75	1. *Melosira sp.*	4,118
	2. *Asterionella sp.*	223
	3. *Fragilaria sp.*	148
	4. *Chlamydomonas sp.*	111
	5. Centric diatoms	111
	Other genera	75
	Total	4,786

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (μg/l)
03/28/75	1	0.6
	2	1.0
07/16/75	1	3.8
	2	4.2
10/30/75	1	2.7
	2	1.7

C. Limiting Nutrient Study:

Due to significant changes in the nutrients in the sample from the time of collection to the beginning of the assay, the results are not considered representative of conditions in the reservoir when the sample was taken (10/30/75).

The reservoir data indicate nitrogen limitation all three sampling times. The mean inorganic nitrogen to orthophosphorus ratios were 1 to 1 in April, 3 to 1 in July, and 3 to 1 in October; and nitrogen limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Oregon National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of January and February when two samples were collected. Sampling was begun in October, 1974, and was completed in September, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Oregon District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in $kg/km^2/year$, at stations A-2 and D-1 and multiplying the means by the ZZ area in km^2.

No known wastewater treatment plants impacted Hills Creek Reservoir during the sampling year.

* See Working Paper No. 175.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Middle Fk. Willamette River	28,760	70.9
Hills Creek	4,395	10.9
b. Minor tributaries & immediate drainage (non-point load) -	7,190	17.7
c. Known municipal STP's - None	-	-
d. Septic tanks	<5	<0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	195	0.5
Total	40,540	100.0

2. Outputs -

Reservoir outlet - Middle Fk Willamette R.	36,130

3. Net annual P accumulation - 4,410 kg.

* Estimate based on three shoreline dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Middle Fk Willamette River	119,655	59.4
Hills Creek	30,910	15.4
b. Minor tributaries & immediate drainage (non-point load) -	38,820	19.3
c. Known municipal STP's - None	-	-
d. Septic tanks* -	30	<0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	11,950	5.9
Total	201,365	100.0

2. Outputs -

Reservoir outlet - Middle Fk Willamette R. 256,375

3. Net annual N loss - 55,010 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Middle Fk. Willamette R.	43	179
Hills Creek	32	226

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Buck Creek	0.041	0.230
Coffeepot Creek	0.050	0.274

* Estimate based on three shoreline dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	3.66	0.40	18.2	loss*

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Hills Creek Reservoir:

"Dangerous" (eutrophic loading)	1.80
"Permissible" (oligotrophic loading)	0.90

* There was an apparent loss of nitrogen during the sampling year. This may have been due to nitrogen fixation in the reservoir, solubilization of previously sedimented nitrogen, recharge with nitrogen-rich ground water, or unsampled point sources discharging directly to the reservoir. Whatever the cause, a similar nitrogen loss has occurred at Shagawa Lake, Minnesota, which has been intensively studied by EPA's former National Eutrophication and Lake Restoration Branch (Malueg et al., 1975).

V. LITERATURE REVIEWED

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VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
4101	BROWNLEE RESERVOIR	0.079	0.560	428.133	16.207	14.500	0.043
4102	DIAMOND LAKE	0.028	0.040	294.500	7.300	6.800	0.011
4103	HELLS CANYON RESERVOIR	0.068	0.640	429.111	18.722	12.400	0.045
4104	HILLS CREEK RESERVOIR	0.038	0.060	435.200	2.333	7.400	0.027
4105	OWYHEE	0.095	0.425	480.417	3.350	13.200	0.064
4106	OXBOW RESERVOIR	0.071	0.690	425.555	10.311	12.200	0.040
4107	SUTTLE LAKE	0.031	0.040	95.000	9.167	6.800	0.020
4108	WALDO LAKE	0.005	0.040	-100.000	0.350	6.800	0.006

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P	INO NO
4101	BROWNLEE RESERVOIR	14 (1)	29 (2)	43 (3)	14 (1)	0 (0)	29 (2)	12
4102	DIAMOND LAKE	86 (6)	93 (6)	71 (5)	57 (4)	86 (5)	86 (6)	47
4103	HELLS CANYON RESERVOIR	43 (3)	14 (1)	29 (2)	0 (0)	29 (2)	14 (1)	12
4104	HILLS CREEK RESERVOIR	57 (4)	57 (4)	14 (1)	86 (6)	57 (4)	57 (4)	32
4105	OWYHEE	0 (0)	43 (3)	0 (0)	71 (5)	14 (1)	0 (0)	12
4106	OXBOW RESERVOIR	29 (2)	0 (0)	57 (4)	29 (2)	43 (3)	43 (3)	20
4107	SUTTLE LAKE	71 (5)	71 (5)	86 (6)	43 (3)	86 (5)	71 (5)	42
4108	WALDO LAKE	100 (7)	93 (6)	100 (7)	100 (7)	86 (5)	100 (7)	57

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4108	WALDO LAKE	579
2	4102	DIAMOND LAKE	479
3	4107	SUTTLE LAKE	428
4	4104	HILLS CREEK RESERVOIR	328
5	4106	OXBOW RESERVOIR	201
6	4101	BROWNLEE RESERVOIR	129
7	4103	HELLS CANYON RESERVOIR	129
8	4105	OWYHEE	128

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR OREGON 08/11/76

LAKE CODE 4104 HILLS CREEK RESERVOIR

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 1007.5

NORMALIZED FLOWS(CMS)

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4104A1	1007.5	53.80	33.98	15.35	20.44	28.88	24.52	16.03	20.95	33.41	37.10	54.09	58.05	33.04
4104A2	668.2	36.81	30.87	30.30	29.45	32.85	20.67	11.38	8.27	7.33	9.49	22.34	29.17	22.37
4104D1	136.5	7.79	6.06	6.03	5.89	6.77	4.05	1.43	0.85	0.81	1.26	4.30	6.60	4.31
4104ZZ	203.6	9.63	7.36	7.36	7.08	8.21	4.81	1.70	0.99	0.99	1.56	5.38	8.21	5.26
4104EF	14.2	0.340	0.425	0.142	0.057	0.028	0.014	0.006	0.003	0.006	0.006	0.028	0.283	0.110
4104IG	47.9	0.708	0.850	0.283	0.142	0.057	0.028	0.014	0.006	0.008	0.014	0.057	0.566	0.224

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 1007.5
SUM OF SUB-DRAINAGE AREAS = 1070.4

TOTAL FLOW IN = 388.11
TOTAL FLOW OUT = 396.61

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4104A1	10	74	36.812	19	37.095				
	11	74	36.812	15	35.113				
	12	74	49.271	16	53.802				
	1	75	58.333	6	49.838	17	75.323		
	2	75	12.205	7	10.421	24	10.307		
	3	75	39.644	7	45.024				
	4	75	34.547	22	33.697				
	5	75	30.299	21	41.626	28	41.343		
	6	75	44.174	10	45.873				
	7	75	21.209	28	14.215				
	8	75	27.609	29	36.812				
	9	75	37.095	16	37.661				
4104A2	10	74	8.212	19	7.759				
	11	74	10.675	15	7.929				
	12	74	26.108	16	41.909				
	1	75	37.095	6	50.687	17	37.095		
	2	75	34.263	7	21.606	24	28.883		
	3	75	33.414	7	29.450				
	4	75	23.305	22	23.078				
	5	75	42.475	21	34.547	28	40.210		
	6	75	37.095	10	39.077				
	7	75	18.094	28	12.997				
	8	75	11.242	29	10.959				
	9	75	9.543	16	9.543				

TRIBUTARY FLOW INFORMATION FOR OREGON 08/11/76

LAKE CODE 4104 HILLS CREEK RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
410401	10	74	0.709	19	0.566				
	11	74	1.501	15	0.566				
	12	74	5.975	16	13.847				
	1	75	9.458	6	13.762	17	12.205		
	2	75	8.778	7	3.823	24	7.362		
	3	75	5.097	7	4.531				
	4	75	3.285	22	3.002				
	5	75	9.061	21	5.862	28	7.900		
	6	75	6.654	10	7.447				
	7	75	1.982	28	0.793				
	8	75	0.623	29	0.595				
	9	75	0.340	16	0.340				
41041F	10	74	0.0	19	0.0				
	11	74	0.014	15	0.0				
	12	74	0.042	16	0.028				
	1	75	0.142	6	1.133	17	0.014		
	2	75	0.850	7	0.566	21	2.265		
	3	75	0.057	7	0.014				
	4	75	0.014	18	0.006				
	5	75	0.008	27	0.003				
	6	75	0.006	10	0.006				
	7	75	0.014	24	0.006				
	8	75	0.0	22	0.0				
	9	75	0.0	12	0.0				
41041G	10	74	0.0	19	0.0				
	11	74	0.028	15	0.008				
	12	74	0.085	16	0.057				
	1	75	0.340	6	2.265	17	0.051		
	2	75	1.982	7	1.557	21	5.663		
	3	75	0.142	7	0.037				
	4	75	0.028	18	0.017				
	5	75	0.020	21	0.008	27	0.008		
	6	75	0.011	10	0.014				
	7	75	0.028	24	0.011	28	0.006		
	8	75	0.0	22	0.0				
	9	75	0.0	12	0.0				

APPENDIX D

PHYSICAL and CHEMICAL DATA

1ORET RETRIEVAL DATE 76/08/12

410401
43 42 23.0 122 25 20.0 3
HILLS CREEK RESERVOIR
41039 OREGON
130991

11EPALES 2111202
0154 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/28	09 40	0000	6.2	11.6	54	47	7.80	22	0.030	0.200K	0.020	0.040
	09 40	0005	6.1	11.6		46	7.70	22	0.020	0.200K	0.020K	0.032
	09 40	0015	6.1	11.6		46	7.60	23	0.020	0.200K	0.020	0.032
	09 40	0050	5.7	11.4		46	7.50	22	0.020	0.200K	0.020	0.032
	09 40	0100	5.1	11.4		47	7.50	22	0.020	0.200K	0.020	0.040
	09 40	0140	5.1	10.8		48	7.40	23	0.020	0.200K	0.030	0.040
75/07/16	14 50	0000	18.5	9.0	78	41	8.40	25	0.050	0.400	0.030	0.012J
	14 50	0005	18.9	9.0		36	9.20	22	0.040	0.300	0.020K	0.013J
	14 50	0015	18.2	8.2		34	8.25	24	0.060	0.300	0.020K	0.015J
	14 50	0040	13.2	10.6		27	8.70	25	0.050	0.300	0.020K	0.026
	14 50	0100	6.8	10.0		24	8.90	26	0.030	0.200K	0.020K	0.030K
	14 50	0150	3.8	15.4		24	8.60	30	0.030	0.200	0.040	0.035J
	14 50	0220	3.0	9.0		28	7.90	28	0.030	0.200	0.050	0.029J
75/10/30	13 40	0000	13.9	9.6	60	38	7.90	30	0.020K	0.200K	0.020	0.007
	13 40	0005	14.0	9.0		48	7.70	33	0.020K	0.200K	0.020K	0.008
	13 40	0018	13.9	9.0		49	7.50	30	0.020K	0.200K	0.020K	0.012
	13 40	0050	11.3	8.2		23	7.35	28	0.020K	0.200K	0.040	0.022
	13 40	0080	7.9	8.2		38	7.20	29	0.020K	0.200K	0.060	0.027
	13 40	0125	6.0	9.0		35	7.10	30	0.020K	0.200K	0.060	0.028
	13 40	0170	5.7	8.4		34	7.05	33	0.020K	0.200K	0.080	0.027

K* VALUE KNOWN TO BE LESS
THAN INDICATED

J* VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 76/08/12

410401
43 42 23.0 122 25 20.0 3
MILLS CREEK RESERVOIR
41039 OREGON
130991

11EPALES 2111202
0159 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/28	09 40	0000	0.044	0.6	
	09 40	0005	0.039		
	09 40	0015	0.038		
	09 40	0050	0.038		
	09 40	0100	0.040		
	09 40	0140	0.059		
75/07/16	14 50	0000	0.017	3.8	
	14 50	0005	0.018		
	14 50	0015	0.020		
	14 50	0040	0.023		
	14 50	0100	0.029		
	14 50	0150	0.040		
	14 50	0220	0.041		
75/10/30	13 40	0000	0.022	2.7	
	13 40	0005	0.022		
	13 40	0018	0.029		
	13 40	0050	0.034		
	13 40	0080	0.041		
	13 40	0125	0.041		
	13 40	0170	0.043		

STORET RETRIEVAL DATE 76/08/12

410402
43 39 52.0 122 25 28.0 3
MILLS CREEK RESERVOIR
41039 OREGON
130991

11EPALES 2111202
0160 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/28	10 00	0000	6.0	11.4	60	33	7.50	21	0.040	0.400	0.030	0.039
	10 00	0005	6.0	11.6		33	7.40	20	0.020	0.200	0.020K	0.033
	10 00	0015	6.0	11.6		32	7.40	20	0.020K	0.200K	0.020K	0.041
	10 00	0050	5.1	11.6		32	7.40	21	0.030	0.200K	0.020K	0.035
	10 00	0100	4.8	11.2		33	7.30	21	0.020	0.200K	0.020K	0.030
	10 00	0156	4.5	10.4		34	7.20	22	0.030	0.200	0.040	0.031
75/07/16	14 15	0000	19.2	9.0	72	16	9.30	29	0.090	1.200	0.080	0.025J
	14 15	0005	19.5	9.6		41	8.90	19	0.050	0.300	0.020	0.015J
	14 15	0015	19.1	9.0		33	7.90	21	0.070	0.200	0.020K	0.020J
	14 15	0040	13.1	8.8		29	7.50	22	0.080	0.300	0.030	0.026K
	14 15	0090	8.6	9.6		20	7.20	25	0.040	0.200K	0.040	0.036J
	14 15	0140	3.7	9.6		28	7.00	25	0.030	0.200K	0.040	0.036J
	14 15	0180	3.0	13.4		15	6.95	27	0.030	0.200K	0.040	0.029J
75/10/30	14 20	0000	13.9	9.8		49	7.00	32	0.020K	0.200K	0.030	0.010
	14 20	0005	13.9	9.2		50	7.25	32	0.020K	0.200	0.020K	0.013
	14 20	0018	13.9	9.0		50	7.20	31	0.020K	0.200K	0.020K	0.014
	14 20	0050	12.3	9.4		47	7.20	31	0.020K	0.200	0.020K	0.016
	14 20	0080	8.2	7.6		40	6.90	33	0.020K	0.200	0.080	0.027
	14 20	0122	6.3	7.8		38	6.90	33	0.020K	0.200	0.030	0.014

K* VALUE KNOWN TO BE LESS
THAN INDICATED

J* VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 76/08/12

410402
43 39 52.0 122 25 28.0 3
MILLS CREEK RESERVOIR
41039 OREGON
130991

11EPALES 2111202
0160 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/28	10 00	0000	0.053	1.0	
	10 00	0005	0.043		
	10 00	0015	0.042		
	10 00	0050	0.044		
	10 00	0100	0.047		
	10 00	0156	0.046		
75/07/16	14 15	0000	0.030	4.2	
	14 15	0005	0.020		
	14 15	0015	0.020		
	14 15	0040	0.022		
	14 15	0090	0.038		
	14 15	0140	0.039		
	14 15	0180	0.045		
75/10/30	14 20	0000	0.023	1.7	
	14 20	0005	0.025		
	14 20	0018	0.026		
	14 20	0050	0.031		
	14 20	0080	0.045		
	14 20	0122	0.061		

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/08/12

4104A1
43 42 40.0 122 25 35.0 4
MID FORK WILLAMETTE RIV
41 15 OAKRIDGE
O/HILLS CREEK RESERVOIR 130991
BELO MILL CRK DAM 2.8 MI SE OF OAKRIDGE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/19	10	30	0.040	0.100K	0.010	0.010	0.015
74/11/15	10	18	0.016	0.700	0.025	0.005	0.020
74/12/16	11	35	0.024	0.200	0.025	0.015	0.030
75/01/06	14	10	0.048	0.100K	0.005	0.025	0.050
75/01/17	13	22	0.056	0.100K	0.008	0.032	0.050
75/02/07	10	32	0.045	0.150	0.020	0.040	0.040
75/03/07	12	20	0.015	0.050K	0.008	0.032	0.040
75/04/22	10	55	0.005	0.400	0.020	0.030	0.030

K VALUE KNOWN TO BE
LESS THAN INDICATED

.ORET RETRIEVAL DATE 76/08/12

4104A2
43 35 25.0 122 26 35.0 4
MID FORK WILLAMETTE RIV
41 15 OAKRIDGE
T/HILLS CREEK RESERVOIR 130991
BNK NEAR RIGDON RD 8.4 MI S HILL CRK DAM
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/19	12	45	0.016	0.100K	0.010	0.040	0.040
74/12/16	13	30	0.024	0.200	0.025	0.030	0.050
75/01/06	11	41	0.008	0.200	0.020	0.050	0.060
75/01/17	12	50	0.008	0.300	0.016	0.032	0.040
75/02/07	11	15	0.008	0.100K	0.024	0.040	0.040
75/02/24	11	03	0.008	0.100	0.008	0.032	0.040
75/03/07	10	48	0.006	0.100K	0.008	0.024	0.030
75/04/22	10	25	0.015	0.450	0.020	0.030	0.030
75/05/21	10	35	0.005	0.050K	0.010	0.020	0.030
75/06/10	12	30	0.005	0.050K	0.005	0.015	0.015
75/07/28	11	00	0.005	0.100	0.010	0.035	0.050
75/09/16	15	15	0.010	0.200	0.005K	0.025	0.060

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

410481
43 35 40.0 122 26 30.0 4
BUCK CREEK
41 15 OAKRIDGE
T/HILLS CREEK RESERVOIR 130991
RIGDON RD BRDG 10.4 MI S OF OAKRIDGE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/19	12	35	0.024	0.100K	0.005	0.035	0.035
74/11/15	11	14	0.008	0.600	0.020	0.030	0.040
75/01/06	14	35	0.008	0.100K	0.030	0.055	0.090
75/01/17	12	43	0.008	0.200	0.008K	0.032	0.050
75/02/07	11	30	0.008	0.100K	0.016	0.032	0.035
75/02/24	10	56	0.008	0.100K	0.008	0.032	0.040
75/03/07	10	43	0.008	0.100K	0.012	0.021	0.030
75/04/22	10	20	0.005	0.300	0.020	0.025	0.030
75/05/21	10	45	0.040	0.200	0.015	0.020	0.030
75/06/10	12	40	0.010		0.015	0.015	0.015
75/07/28	11	20	0.005	0.200	0.010	0.030	0.050
75/09/16	15	20	0.010	0.400	0.005K	0.035	0.050

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

4104C1
43 37 15.0 122 25 03.0 4
COFFEEPOT CREEK
41 15 OAKRIDGE
T/HILLS CREEK RESERVOIR 130991
UNPVD RD BRDG 8.5 MI S OF OAKRIDGE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/19	12	10	0.056	0.300	0.015	0.040	0.045
74/11/15	10	47	0.016	1.050	0.020	0.045	0.050
74/12/16	14	00	0.032	0.100	0.015	0.045	0.060
75/01/05	14	55	0.016	0.100	0.010	0.050	0.080
75/01/17	12	55	0.016	0.200	0.008K	0.048	0.050
75/02/07	11	00	0.008	0.100	0.024	0.048	0.050
75/02/24	10	43	0.008	0.500	0.010	0.048	0.070
75/03/07	11	33	0.008	0.100K	0.016	0.040	0.040
75/04/22	10	00	0.005	0.050K	0.010		0.040
75/05/21	10	20	0.040	0.400	0.065	0.050	0.040
75/06/10	13	00	0.015	0.050	0.010	0.005	0.010
75/07/28	10	45	0.020	0.250	0.015	0.045	0.050
75/09/16	15	05	0.025	0.100	0.015	0.040	0.060

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

410401
43 41 00.0 122 22 15.0 4
HILLS CREEK
41 15 OAKRIDGE
T/HILLS CREEK RESERVOIR 130991
BNK .2 MI SE OF KITSON HOT SPRINGS
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/19	11 10		0.016	0.100	0.010	0.030	0.030
74/11/15	09 55		0.008	0.300	0.015	0.025	0.030
74/12/16	11 15		0.048	0.200	0.030	0.035	0.040
75/01/06	13 50		0.016	0.400	0.050	0.040	0.060
75/01/17	12 00		0.016	0.100K	0.096	0.032	0.035
75/02/07	09 55		0.008	0.200	0.024	0.010	0.020
75/02/24	10 07		0.008	0.125	0.008K	0.028	0.035
75/03/07	10 55		0.008	0.150	0.008	0.028	0.028
75/04/22	09 25		0.005	0.200	0.015		0.020
75/05/21	09 45		0.040	0.350	0.025	0.012	0.031
75/06/10	13 00		0.020	0.050K	0.010	0.030	0.030
75/07/28	10 15		0.005	0.100	0.007	0.025	0.030
75/09/16			0.010	0.400	0.005	0.015	0.040

K VALUE KNOWN TO BE LESS THAN INDICATED